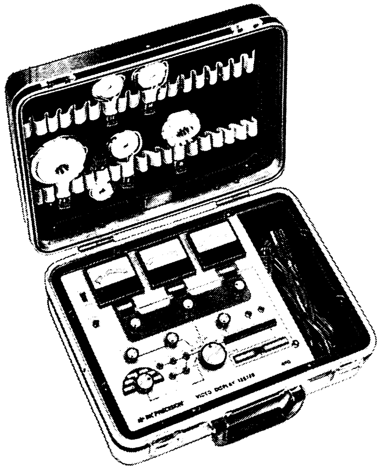
# INSTRUCTION MANUAL

B+K PRECISION®

# MODELS 480 and 490




# VIDEO DISPLAY TESTERS

B+K PRECISION®

## TEST INSTRUMENT SAFETY

**WARNING**

There is a certain amount of danger from electrical shock if this equipment is used improperly, or from contacting high voltage in the television set, video monitor, computer terminal, etc. in which the cathode ray tube being tested is installed. This instrument is intended for use only by qualified electronics technicians who are trained to work safely in the presence of high voltage. Be alert to the following hazards when using the Model 480/490 CRT Tester/Rejuvenator:

1. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Higher voltages pose a greater threat because they can more easily produce a lethal current. However, voltage as low as 35 volts dc or ac rms should be considered dangerous and hazardous since it can produce a lethal current under certain conditions.

2. Many television sets and other devices with CRT's are transformerless "hot chassis" powered, where one side of the ac power line is connected directly to the chassis. If such equipment does not have a polarized power plug to prevent insertion the "wrong" way, a serious shock hazard exists if the chassis is touched. Additionally, damage to the CRT tester/rejuvenator or the TV set or monitor could result. Unplug any "hot chassis" TV set or monitor from its ac outlet before attempting to access the CRT (just turning off the set does not eliminate the hazard). To be on the safe side, treat all equipment as "hot chassis" type unless you are sure it has a floating or earth ground chassis.

3. When testing any CRT that is installed in a chassis, first disconnect the chassis power plug from the ac line outlet. Do not apply power to the TV or monitor chassis at any time during the test of a CRT.

(continued on inside back cover)

# Instruction Manual

# for

# Models 480 and 490

# VIDEO DISPLAY

# TESTERS

Covered by one or more of the
following U.S. Patents:
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3,961,242
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# INTRODUCTION

The **B & K-Precision** Models 480 and 490 Video Display Testers are designed to accurately test and rejuvenate a large variety of cathode-ray tubes, both color and monochrome (where "monochrome" includes black & white TV tubes as well as computer CRT's of single phosphor).

Both units utilize a "road map" control panel design to reduce testing time. Moreover, the Model 490 uses digital multiplexing circuits - a patented TriDynamic® approach which reduces the test process to one simple procedure.

## SPECIAL FEATURES

Both instruments are designed to provide rapid testing and reduced human error. Their features include:

1. A control panel which guides the user easily through the correct test sequence.
2. Continuously variable heater, G1, and G2 voltages, which can be accurately set on a meter. Common heater voltages are pre-marked on the meter scale.
3. A color tracking feature which reduces the time required for determining proper color gun tracking.
4. A patented rejuvenation capability, automatically timed and operated by simply depressing one button. The rejuvenate feature provides maximum cathode restoration and minimizes the possibility of cathode damage.
5. Function switching between rejuvenation and emission test, permitting instant evaluation of restoration effectiveness.
6. Rugged polyethylene case with metal frame and hinges, replaceable latches, and removable lid. Extensive storage space is provided for cords and CRT adapters.

Additionally, the Model 490 provides the following features:

1. Three precision meters that display emission from all three guns simultaneously, to minimize testing time.
2. Simultaneous leakage detection between all important elements, including cathode-to-cathode leakage.
3. Simplified automatic life test.
4. One-button test for continuity to focus electrodes.
5. Short indicator lamp which shows instantly when a G1-K short has been successfully removed.

## SPECIFICATIONS

(All specifications apply to both models unless specified otherwise.)

| | |
|---|---|
| **Types of CRT's Tested:** | Most monochrome, color and projection TV CRT's, video monitor CRT's, and computer terminal CRT's. |
| **Tests Performed:** | Emission.<br>Leakage.<br>Tracking (color tubes).<br>Life.<br>Focus continuity (Model 490 only). |
| **Restoring Functions:** | Shorts removal.<br>Gun cleaning and balancing.<br>Cathode rejuvenation. |
| **Meter(s):** | Model 480: one, 4-1/2", D'Arsonval movement.<br>Model 490: three, 2-1/2", D'Arsonval movement. |

**Meter Indications:**

| | |
|---|---|
| Emission: | 0 to 2 mA. |
| Restoring Current: | 0 to 2 scale. |
| Heater Voltage: | 0 to 15 V. |
| G1 Bias Voltage: | 0 to 100 V (Model 480).<br>30 to 100 V (Model 490). |
| Leakage: | Good/bad indication (Model 480 only). |
| Power Line Voltage: | 100 to 130 V (Model 490 only). |

**Test Voltages:**

| | |
|---|---|
| Heater: | 0 to 7 V @ 2 A.<br>7 to 14 V @ 600 mA. |
| G1 Bias: | 0 to -100 VDC (Model 480).<br>-30 to -100 VDC (Model 490). |
| G2 Supply: | 0 to 450 VDC (Model 480).<br>0 to 350 VDC (NORMAL on Model 490).<br>180 to 530 VDC (HIGH on Model 490). |

| | |
|---|---|
| **Accessories:** | |
| CRT Socket Adapters: | Six supplied; optional adapters available for most common TV amd monitor CRT's. |
| Set-up Chart: | Shows adapter number and heater test voltages. |
| **Power Requirements:** | 117 VAC, 60 Hz, 40 Watts. 117/230 VAC, 50/60 Hz versions available for both models. |
| **Case:** | Heavy-duty polyethylene with metal frame and removable lid. Storage space provided for cords and adapters. |
| **Dimensions:** | 14-3/4 x 11-1/2 x 7" (375 x 292 x 178 mm). |
| **Weight:** | Model 480: 11-3/4 lbs (5.3 kg).<br>Model 490: 14-1/2 lbs (6.5 kg). |

## CONTROLS AND INDICATORS

MODEL 480
(Refer to Fig. 1)

1. **Function Switch.** Selects main operating mode: OFF/HTR RANGE, SET HTR, LEAKAGE, SET G1, SET CUTOFF, READ EMISSION, SET TRACKING, REMOVE SHORTS, CLEAN-BALANCE, REJUVENATE.

2. **RESTORE Pushbutton.** Applies restoring voltage between G1 and cathode, and simultaneously interrupts heater voltage. Also used for CLEAN-BALANCE and REMOVE SHORTS procedures.

3. **TRACKING Control.** Varies emission readings of all guns proportionally from zero to full value.

4. **G2 Control – BLUE.** Adjusts value of G2 voltage (blue gun) to SET CUTOFF condition of test.

5. **G2 Control – GREEN.** Adjusts value of G2 voltage (green gun) to SET CUTOFF condition of test.

6. **G2 Control – RED/B&W.** Adjusts value of G2 voltage (red gun or B&W (monochrome) tube) to SET CUTOFF condition of test.

7. **Meter.** Indicates: heater voltage, leakage, G1 volts, emission, tracking, cleaning, balancing, and rejuvenation, depending on operating mode.

8. **POWER Lamp.** Indicates power is "on".

9. **Gun Selector Switch.** Selects red/B&W, green, or blue gun.

10. **G1 VOLTAGE Control.** Adjusts control grid bias voltage; range: 0 to -100 VDC.

11. **SET HEATER Control.** Fine adjustment of heater voltage ±2 VAC.

12. **HTR RANGE Control.** Coarse adjustment of heater voltage.

| | |
|---|---|
| 0-4 position: | 0 - 4 VAC at 2.0 A; |
| 4-7 position: | 4 - 7 VAC at 2.0 A; |
| 7-9 position: | 7 - 9 VAC at 0.6 A; |
| 8-11 position: | 8 - 11 VAC at 0.6 A; |
| 10-12 position: | 10 - 12 VAC at 0.6 A; |
| 12-14 position: | 12 - 14 VAC at 0.6 A. |

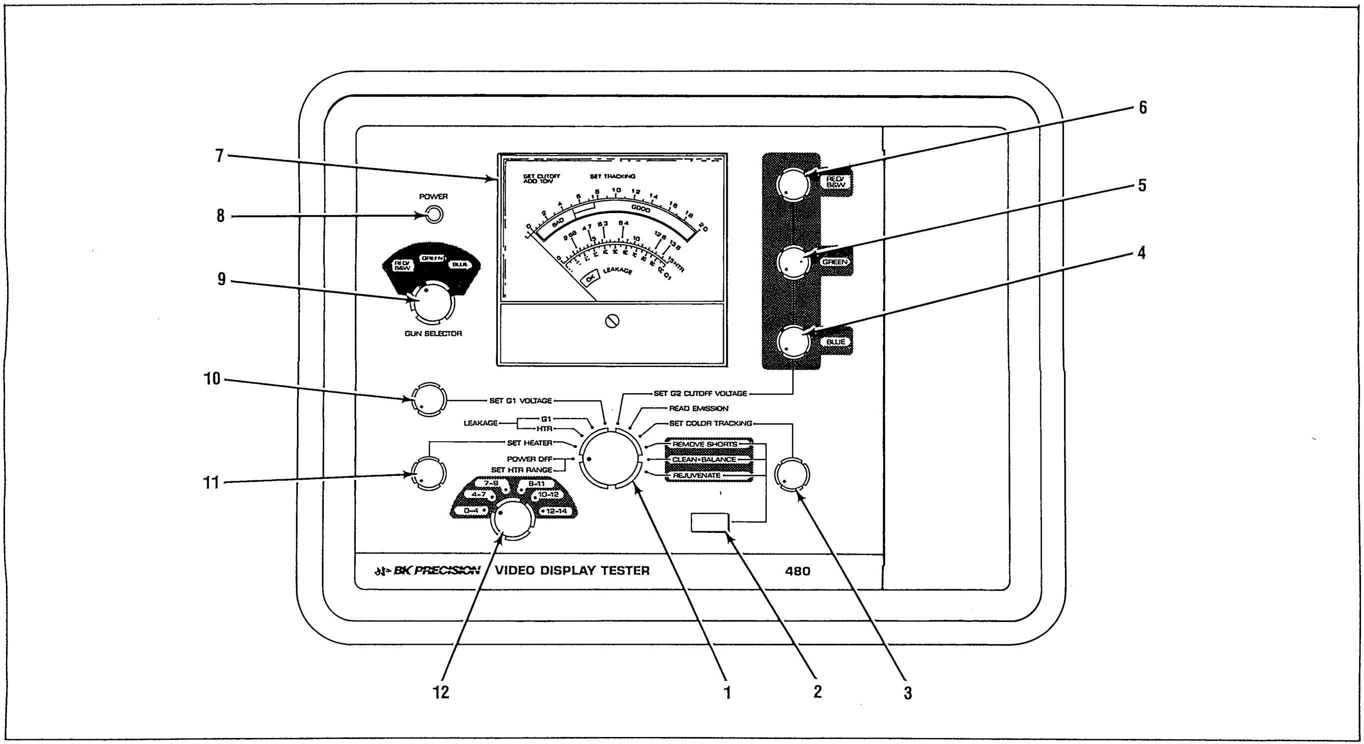



Fig. 1. Model 480 controls and indicators.

MODEL 490
(Refer to Fig. 2)

1. **Function Switch.** Selects main operating mode: OFF, SET-UP, SET CUTOFF, TEST, RESTORE.

2. **TRACKING Pushbutton.** Activates tracking adjustment control (10).

3. **LIFE Pushbutton.** Automatically reduces heater voltage by 15% from the value set on RED/B&W meter (19).

4. **REJUVENATE/CLEAN-BALANCE Switch.** Selects value of high voltage to be used for REJUVENATE or CLEAN-BALANCE operation.

5. **FOCUS OK Pushbutton.** Activates focus electrode continuity test.

6. **REMOVE SHORTS Pushbutton.** Discharges capacitor through short between G1 and cathode.

7. **RESTORE Ballast Lamp.** Indicates presence of restoring current.

8. **G1-K SHORT Lamp.** Indicates presence of short circuit between G1 and cathode.

9. **FOCUS OK Lamp.** Indicates continuity from CRT base pin to focus electrode.

10. **TRACKING Control.** Varies emission readings of all guns proportionally from zero to full value.

11. **G2 Control - BLUE.** Adjusts value of G2 voltage (blue gun) to SET CUTOFF condition of test.

12. **RESTORE Pushbutton - BLUE.** Applies restoring voltage between G1 and cathode (blue gun), and simultaneously interrupts heater voltage. Also used for CLEAN-BALANCE procedure.

13. **BLUE Meter.** Reads emission of blue gun. Reads power line voltage when function switch (1) is in SET-UP position.

14. **G2 Control - GREEN.** Adjusts value of G2 voltage (green gun) to SET CUTOFF condition of test.

15. **RESTORE Pushbutton - GREEN.** Applies restoring voltage between G1 and cathode (green gun), and simultaneously interrupts heater voltage. Also used for CLEAN-BALANCE procedure.

16. **GREEN Meter.** Reads emission of green gun. Reads value of G1 bias voltage when function switch (1) is in SET-UP position.

17. **G2 Control - RED/B&W.** Adjusts value of G2 voltage (red gun or B&W (monochrome) tube) to SET CUTOFF condition of test.

18. **RESTORE Pushbutton - RED/B&W.** Applies restoring voltage between G1 and cathode (red gun or B&W (monochrome) tube), and simultaneously interrupts heater voltage. Also used for CLEAN-BALANCE procedure.

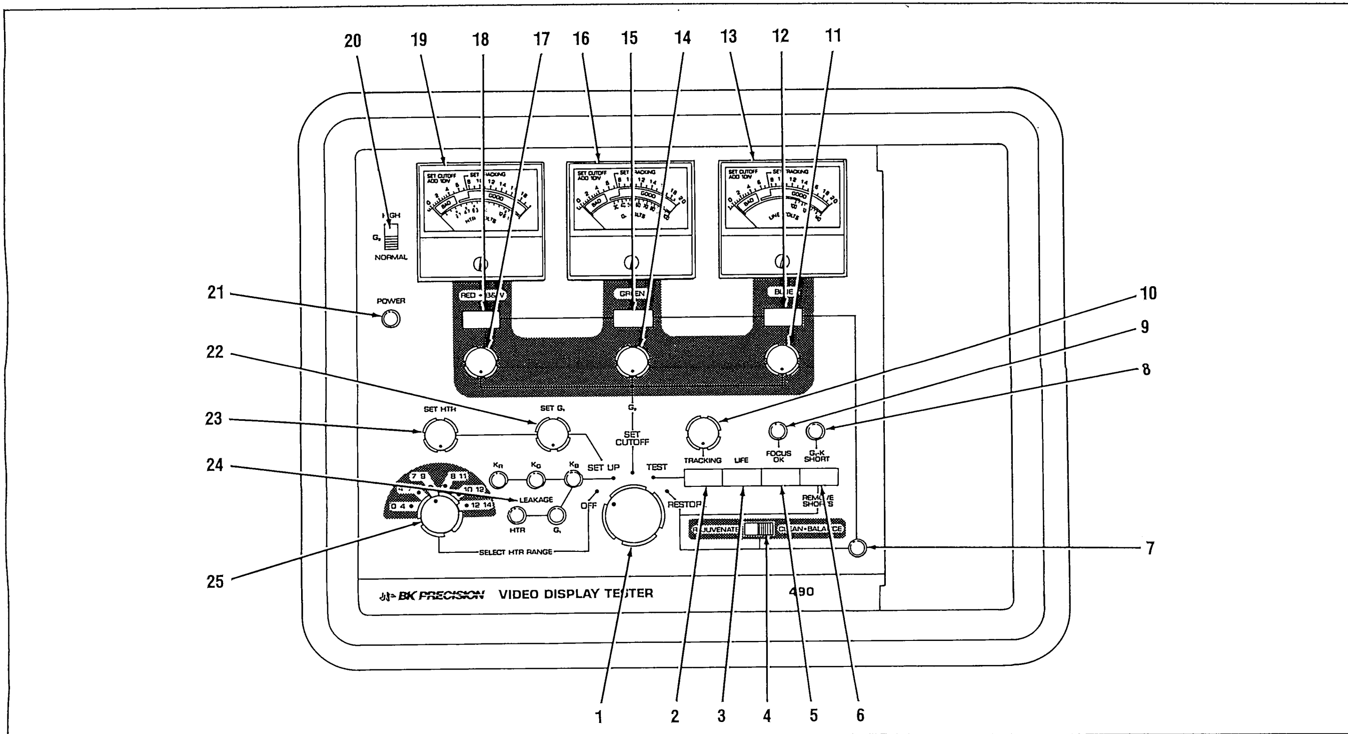



Fig. 2. Model 490 controls and indicators.

19. **RED/B&W Meter.** Reads emission of red gun or B&W (monochrome) tube. Reads heater voltage when function switch (1) is in SET-UP position.

20. **G2 NORMAL/HIGH Switch.** Selects two ranges of G2 supply voltage:

| | |
|---|---|
| NORMAL position: | 0-350 VDC; |
| HIGH position: | 180-530 VDC. |

21. **POWER Lamp.** Indicates power is "on".

22. **SET G1 Control.** Adjusts control grid bias voltage when function switch (1) is in SET-UP position.

23. **SET HTR Control.** Fine adjustment of heater voltage ±2 VAC.

24. **LEAKAGE Lamps.** Indicate leakage from cathodes to heater or G1, or between cathodes, when function switch (1) is in SET-UP position.

25. **HTR RANGE Switch.** Coarse adjustment of heater voltage.

| | |
|---|---|
| 0-4 position: | 0 - 4 VAC at 2.0 A; |
| 4-7 position: | 4 - 7 VAC at 2.0 A; |
| 7-9 position: | 7 - 9 VAC at 0.6 A; |
| 8-11 position: | 8 - 11 VAC at 0.6 A; |
| 10-12 position: | 10 - 12 VAC at 0.6 A; |
| 12-14 position: | 12 - 14 VAC at 0.6 A. |

**WARNING**

*If the CRT to be tested is mounted in the TV set or monitor, make sure that power to the set is removed* ***by unplugging it*** *(simply turning off the power switch is not adequate). A shock hazard and possibility of damage to the Model 480/490 exists if an attempt is made to test the CRT with the TV set or monitor operating.*

*Also, completely discharge the high voltage (anode) supply of the CRT before connecting to the tester. Failure to do so may damage the instrument. The anode of many CRT's retains high voltage for long periods of time after power is removed.*

## PRELIMINARY

### Introduction

The following procedure describes in detail the use of the Model 480/490. In addition, comments and notes are provided regarding the significance of the readings to aid the user in interpreting the measurements obtained.

Because of the unique design of these instruments, all tube types are tested in the same manner, regardless of gun structure. After the user has become thoroughly familiar with the instructions and the instrument itself, he will need only to refer to the SET-UP CHART booklet.

### How To Use the SET-UP CHARTS

For convenience, color and B&W (monochrome) CRT's are grouped separately. In each group the tubes are listed alphanumerically, with numeric CRT's listed first. See the SET-UP CHARTS for any other special conditions that may arise.

## TUBE EVALUATION

### Set-up

Both Models

1. Set the function switch (large dial in center of unit) to OFF.

2. Plug the line cord into a convenient power outlet.

3. Set all variable controls fully counterclockwise.

4. Locate the type number of the CRT to be tested in the SET-UP CHART.

5. Select the adapter by the number indicated and connect it to the adapter cable.

6. Model 490 only: Place the G2 NORMAL/HIGH switch in the NORMAL position.

7. Set the HTR RANGE switch to the range which includes the heater voltage shown in the SET-UP CHART.

8. If the CRT to be tested is mounted in the TV set or monitor, make sure that power to the set is removed *by unplugging it*. Note the WARNING at the beginning of this chapter.

9. Connect the socket adapter to the base of the CRT, taking care to align the keyway properly.

10. Set the function control to SET HEATER on the 480, or SET UP on the 490.

11. Carefully adjust the SET HTR control while observing the HTR VOLTS scale of the meter (RED/B&W meter on 490) for the heater voltage indicated in the SET-UP CHART. For convenience, the most common heater voltages are precisely marked.

12. Model 490 only: The LINE VOLTS scale on the BLUE meter automatically monitors line voltage present at the time of the test while the FUNCTION switch is in the SET-UP position. This may be helpful in diagnosing some symptoms related to low line voltage. For example, a marginal picture tube might perform very poorly with low line voltage because of the reduced heater voltage.

**Leakage Test**

Model 480

1. Rotate the function switch to HTR LEAKAGE. Leakage between heater and cathode is okay if the reading on the meter is within the yellow area of the bottom scale marked "Leakage". For color tubes only, rotate the GUN SELECTOR switch to the other two guns.

2. Rotate the function switch to G1 LEAKAGE. Leakage between G1 and cathode is okay if the reading of meter is within the yellow area of the bottom scale. For color tubes only, rotate the GUN SELECTOR switch to the other two guns.

3. Consult the "Notes on Leakage" section.

Model 490

1. With the function switch in the SET-UP position, observe the five LEAKAGE lamps. When glowing, these lamps automatically indicate leakages between cath-

odes, or from any cathode to the heater or to G1. For example, if the KB, KR, and G1 lamps glow, it is an indication of leakage between the blue cathode, the red cathode, and the control grid. Only those elements which have leakage between them in the order of two megohms or less, will be indicated by the lamps glowing.

**NOTE**

If the leakage lamps glow very faintly, even though the CRT tests normal in all other functions, the cause may be dirt or other contamination between the tube base pins. This can usually be ignored.

2. Consult the "Notes on Leakage" section.

Notes On Leakage

**Heater-Cathode Leakage:** Leakage between heater and cathode cannot be repaired. When such a leakage is determined to be the cause of set malfunction, it is necessary to replace the CRT. If the heater power source permits the use of a filament isolating transformer, its use may restore normal operation.

**Grid-to-Cathode Leakage:** Excessive leakage or a short between the control grid and cathode is a common fault in CRT's.

On the 480, any current path below two megohms will cause the meter to read excessive leakage (near full scale or higher).

On the 490, any current path below two megohms will light the G1-K SHORT lamp. Shorts and leakage paths below 20k ohms will *also* light the G1-K SHORT lamp when the function switch is in the RESTORE position.

If only leakage is indicated, restore the tube by using the CLEAN-BALANCE procedure; if a G1-K short exists, use the REMOVE SHORTS procedure (see "RESTORING THE CRT").

**Cathode-to-Cathode Leakage:** (Detectable by Model 490 only.) Excessive leakage between cathodes can sometimes result in TV set or monitor malfunction. Such leakage cannot be repaired.

**Set G1 Volts**

Model 480

Rotate the function switch to the SET G1 VOLTAGE position. Set G1 VOLTAGE to the value specified in the SET-UP CHART (50 V unless otherwise indicated). Use the G1 control and read voltage on the G1 voltage scale of the meter.

Model 490

Adjust the SET G1 control while observing the G1 VOLTS scale of the GREEN meter until the meter indicates the value of G1 specified in the SET-UP CHART (50 V unless otherwise indicated).

## Set Cut-off

Both Models

1. Set the function switch to the SET (G2) CUTOFF position. The meter on the Model 480, and all three meters on the Model 490, should read zero or slightly above or below zero.

2. Slowly advance each of the three G2 controls (RED/B&W, GREEN, BLUE) clockwise until the meter rises one small division of the meter scale.
   a. Model 480: use the GUN SELECTOR switch to select each gun in turn, observing each reading on the instrument's main meter.
   b. Model 490: use the three separate meters simultaneously.

   This adjustment sets the G2 voltage at the value for spot cut-off of each color gun.

3. If a tube or gun cannot be brought out of cut-off by advancing the G2 control fully clockwise, then:
   a. Model 480: check the tube for presence of glowing heater. If heater is glowing proceed to REJUVENATE (see "RESTORING THE CRT").
   b. Model 490: reset the three G2 controls to fully counterclockwise and place the G2 NORMAL/HIGH switch in the HIGH position. Then repeat steps 1 and 2 above. If tube or gun still cannot be brought out of cut-off, check for presence of glowing heater. If heater is glowing roceed to REJUVENATE (see "RESTORING THE CRT").

**NOTE**
(Both models)

For monochrome (B&W, amber, etc.) and projection tubes, use only the RED/B&W G2 control, unless otherwise instructed in the SET-UP CHART. Keep the other G2 controls turned fully counterclockwise.

## Emission Test

Both Models

Rotate the function switch to the next position clockwise:
a. "READ EMISSION" on the Model 480. The meter will indicate the cathode emission current for each of the three electron guns. Use the GUN SELECTOR switch to check each gun.
b. "TEST" on the Model 490. The three meters will indicate the cathode emission current for each of the three electron guns simultaneously.

With both models, the meter readings may read beyond the full scale deflection. This indicates that the tube has excellent emission. A greater than full scale reading will not in any way damage the instrument. In some cases, the current may rise to approximately 1/2 or 3/4 scale and then slowly decrease. Evaluation of emission should be made when the readings have stabilized. In all cases, if the emission readings stay well within the green (GOOD) area, the emission characteristics of the tube may be considered acceptable. *If emission reads in*

the red (BAD) area, proceed to REJUVENATE (see "RESTORING THE CRT").

**Tracking Test**

Model 480

1. Set the function switch to the SET COLOR TRACKING position..

2. Observe the meter reading for each gun using the GUN SELECTOR switch. Rotate the TRACKING knob so that the pointer of the highest gun reading coincides with the SET TRACKING line located at the high end of the yellow wedge on the meter scale.

3. Using the GUN SELECTOR switch, observe the other two gun readings. If they are both within the yellow wedge on the meter, the tracking ratio of the CRT is acceptable. If the tube does not track, proceed to CLEAN-BALANCE (see "RESTORING THE CRT").

Model 490

1. With the function switch still set to TEST, depress and hold the TRACKING pushbutton.

2. With the TRACKING button depressed, rotate the TRACKING knob so that the pointer of the highest reading meter coincides with the SET TRACKING line located at the high end of the yellow wedge on the meter scale.

3. Observe the other two meters and note if the readings are within the yellow tracking wedge on each meter. If all three pointers are within the yellow wedges, the tracking ratio of the CRT is acceptable. If the tube does not track, proceed to CLEAN-BALANCE (see "RESTORING THE CRT").

4. When the TRACKING button is released, the three meters immediately will return to the original emission readings that were obtained in the emission test. The tracking pushbutton may be depressed as often as desired without affecting the calibration of the emission readings.

**Life Test**

Model 480

1. Judgement of life expectancy is obtained by observing the "warm-up" and "cool-off" behavior of the cathode. To make these observations, set the function switch back to the READ EMISSION position. Depressing the RESTORE pushbutton then interrupts the heater circuit and makes it possible to observe the rate at which the emission rises and falls as the cathode heats up and cools down. Use the GUN SELECTOR switch to observe each gun.

2. Consult the "Notes on Life Expectancy" section.

3. If life expectancy is poor, proceed to CLEAN-BALANCE (see "RESTORING THE CRT").

Model 490

1. With the function switch still in the TEST position, depress and hold the LIFE pushbutton and allow the emission readings to stabilize. For acceptable long-term CRT performance, the readings should stay in the green (GOOD) area. The less the emission drops, the longer the life expectancy of the tube.

2. While holding down the LIFE button, depress the TRACKING button and perform the TRACKING test previously described. For acceptable long-term performance, the CRT should maintain tracking with the LIFE test button held down.

3. Release the LIFE and TRACKING buttons.

4. Life expectancy can also be judged by interrupting the heater circuit and observing "heat-up" and "cool-off" behavior of the cathode. Pressing the RED/B&W, GREEN, or BLUE pushbuttons provides such a test. Consult the "Notes on Life Expectancy" section.

5. If life expectancy is poor, proceed to CLEAN-BALANCE (see "RESTORING THE CRT").

Notes on Life Expectancy

Interrupting the heater circuit and observing heating and cooling of the cathode can be used for a life expectancy judgement with either the Model 480 or 490.

If, for instance, during warm-up, one gun reaches full emission much more slowly than the other two, it is an indication that there may be very little good material left on that cathode, or that its heater has been dislodged away from the cathode, causing lower than normal cathode temperature. In either instance, it is a further indication that short life may be expected from that gun. A good tube will reach full emission levels and ***will track*** within two minutes.

Similarly, the "cool-off" characteristic can provide another clue for judging life expectancy. Observe the time it takes for emission from each gun to fall after the heater voltage is interrupted. If, for instance, two guns maintain full emission for 7 to 10 seconds, and the third gun falls rapidly after 3 or 4 seconds, short life can be expected from that gun.

**Focus Electrode Continuity Test (Model 490 only)**

With the function switch still in the TEST position, depress the FOCUS OK pushbutton. Observe the FOCUS-OK lamp. If this lamp glows or flickers, the focus electrode continuity to the tube base pin is good.

**NOTE**

It is also possible to check for an open interconnection in color CRT's with individual focus electrodes that are internally connected by welded straps. To do this, push the FOCUS OK button and observe the three emission readings on the meters.

If all three meter readings drop approximately the same amount, the inter-electrode continuity is good.

If one or two meter readings drop slightly while the other drops to near zero, there is no continuity to the focus electrode of the ***low reading gun***, even though the FOCUS-OK lamp glows.

If the tube tests bad for focus continuity, a decision to replace the tube should be based on actual performance of the TV set or monitor. If the focus is not objectionable to the customer, the CRT need not be replaced.

## RESTORING THE CRT

The Model 480 and Model 490 each employ three restoring functions: REMOVE SHORTS, CLEAN-BALANCE, and REJUVENATE.

### Notes On Leakage and Shorts

Model 480

Excessive leakage (mid-scale reading) is most successfully removed by the CLEAN-BALANCE procedure. Low resistance or a short between the control grid and cathode will show up in the previous LEAKAGE test (high or full scale meter reading). This kind of short can usually be removed by the REMOVE SHORTS procedure.

Model 490

Excessive leakage or a short between the control grid and cathode will show up in the previous LEAKAGE test. A low resistance short (less than 20k ohms) can be removed by the REMOVE SHORTS procedure. High resistance leakage is most successfully removed by the CLEAN-BALANCE procedure.

### Remove Shorts Procedure

Model 480

1. Set the function switch to the REMOVE SHORTS position.
2. Set the GUN SELECTOR switch to the desired gun.
3. Depress the RESTORE pushbutton and release.
4. Return the function switch to G1 LEAKAGE. The meter will indicate whether or not the short has been removed. Repeat steps 1, 2, and 3 if necessary.
5. After the short is removed, resume the testing procedure.

Model 490

1. Set the function switch to the RESTORE position.
2. Observe the G1-K lamp. If it is not glowing, a high resistance leakage is indicated; use the CLEAN-BALANCE procedure.

3. If the G1-K lamp glows, push the REMOVE SHORTS button and release. If the short has been successfully removed, the lamp will not glow.

4. If the lamp continues to glow, repeat step 3 several times. Wait 5 to 10 seconds between operations. If the short has not been successfully removed, reduce the heater voltage by turning the HTR RANGE switch to the lowest range. If the G1-K SHORT lamp goes out as the cathode cools, it indicates that the short may be due to mechanical expansion of the cathode. Such shorts usually cannot be removed.

5. After the short is removed, resume the testing procedure.

**NOTE**

One or more LEAKAGE lamps may glow temporarily if the function switch remains in the RESTORE position for longer than 15 seconds. Also, if returning to SET-UP to check leakage, wait at least one minute to get a true leakage indication.

**Note on Cleaning/Balancing**

Both Models

Cleaning/balancing is a low energy restoring operation. It can be used safely on all tubes to eliminate surface contamination causing high resistance leakage or for further improving the emission of a fairly good cathode to restore tracking or increase life expectancy.

**Clean/Balance Procedure**

Both Models

1. Set switches as follows:
   a. Model 480: set the function switch to CLEAN-BALANCE.
   b. Model 490: set the function switch to RESTORE and the REJUVENATE/CLEAN-BALANCE switch to CLEAN-BALANCE.

   In both cases, wait 20 to 30 seconds. Observe the CRT heater for increased brightness from the higher heater voltage.

2. Perform the following:
   a. Model 480: Select the desired gun using the GUN SELECTOR switch. Depress and hold the RESTORE pushbutton.
   b. Model 490: Depress and hold the appropriate RESTORE button (RED/B&W, GREEN, BLUE) for the desired gun.

   In both cases, the meter should rise immediately to a value near midscale. After several seconds or more, depending upon the condition of the cathode, the pointer will begin to fall. It usually will fall smoothly to some low value.

3. Release the pushbutton when the pointer reaches 0.2. If the pointer drops erratically and then "hangs-up" at a reading greater than 0.2, wait several seconds and then

release the pushbutton. (On the Model 490, also observe the G1-K SHORT lamp. If it is glowing, remove the short before proceeding further.)

4. If LEAKAGE was being removed, immediately return the function switch to G1 LEAKAGE on the Model 480, or SET-UP on the Model 490. If balancing or "touch-up" was being done, immediately return the function switch to READ EMISSION on the Model 480, or TEST on the Model 490. In either case, resume testing.

5. If the CLEAN-BALANCE procedure was not successful and the condition of the CRT is still unsatisfactory, use the REJUVENATE procedure.

**Notes On Rejuvenating**

Both Models

Rejuvenation is a higher energy procedure then CLEAN-BALANCE, used for restoring cathodes when the emission is below useable levels. High level rejuvenation of one gun can occasionally reduce the previous emission reading of another gun, particularly if that gun had just been rejuvenated. Therefore, after rejuvenation, it is often desirable to "touch-up" by cleaning and balancing one or more of the guns in order to achieve good tracking.

**Rejuvenate Procedure**

1. Set switches as follows:
   a. Model 480: set the function switch to REJUVENATE.
   b. Model 490: set the function switch to RESTORE, and the REJUVENATE/CLEAN-BALANCE switch to REJUVENATE.

   In either case, wait 20 to 30 seconds.

2. Perform the following:
   a. Model 480: Select the desired gun using the GUN SELECTOR switch. Depress and hold the RESTORE pushbutton.
   b. Model 490: Depress and hold the appropriate RESTORE button (RED/B&W, GREEN, BLUE) for the desired gun.

   In both cases, the pointer will immediately rise to about 3/4 scale. (On the Model 490, the RESTORE ballast lamp (lower right hand corner, red lamp) will glow brightly.) After several seconds, the pointer will begin to fall. Often the pointer will fall erratically or hesitate near midscale, rise slightly, and then continue to fall. This behavior is usually accompanied by observable sparking and sputtering action between the grid and cathode.

3. Release the pushbutton when the pointer reaches 0.4 or just as it crosses into the red area of the meter. If the emission does not fall to 0.4 after several seconds, release the pushbutton immediately. (On the Model 490, observe the G1-K SHORT lamp to see if a short was created by the rejuvenation process. If a short exists, use the REMOVE SHORTS procedure).

4. On the Model 480, return to READ EMISSION; on the Model 490 return to TEST. Allow time for readings to stabilize. A rapid judgement of relative improvement

can now be made. For greater accuracy, repeat SET G2 CUTOFF voltage.

5. Repeat LIFE and TRACKING tests. If slight further improvement is needed, or if rejuvenation caused lower emission from one of the other guns, use the CLEAN-BALANCE procedure.

6. If the CLEAN-BALANCE procedure after rejuvenation does not give the necessary improvement, repeat REJUVENATE. Most cathodes will achieve 90% or more of the possible improvement in a single operation. Some will require two or three cycles of rejuvenation for maximum improvement. Further rejuvenation generally causes lower emission and shorter life. The fewer rejuvenation cycles that are used to achieve satisfactory emission, the greater will be the life expectancy.

**Further Notes on Rejuvenation**

If the meter pointer does not rise when the button is pushed, it indicates that successful rejuvenation is probably not possible. If the reason for lack of emission is an *extremely* inactive (contaminated) cathode, it is sometimes possible to start the rejuvenation process by applying even higher heater voltage than normally used for rejuvenation. To try this, go back to SET-UP and increase the heater voltage approximately 25% above the *normal* setting (8.0 V for 6.3 V tubes). Then return to REJUVENATE and attempt rejuvenation. Since the tube is not useful anyway, the risk is small. The greatest danger is that excessive heater voltage will expand the cathode so far that a short to G1 will be created. Also, of course, the heater itself could be burned open by the higher voltage, although this occurs less frequently than a short.

If all three guns show initial low emission (BAD), rejuvenation of one gun will often result in some improvement of the other two guns. (This is caused by the elevated heater voltage which is a mild form of rejuvenation in itself.) These guns should also be rejuvenated, however, even though the emission may have been improved enough so that they read in the GOOD region.

## MODEL 480

### Leakage Test

The leakage limit scale in the Model 480 is more liberal than the manufacturer's limit for a new tube. This is the limit at which one might expect trouble to begin showing up in a typical TV set or monitor.

In both leakage positions, a high sensitivity meter clearly indicates the acceptable leakage limits (see Fig. 3).

### Quality Tests (G2 Cutoff, Emission, and Tracking)

The current indicated on the Model 480 meter is "true" beam current - that is, only the current passing through the G1 aperture. A GOOD emission indication on the meter, therefore, assures that (given the high voltage) the CRT gun is capable of producing adequate high-light brightness on the face of the picture tube.

Three individual G2 controls are adjusted accurately for spot cutoff for each color gun. These controls are sufficiently low resistance to avoid regulation problems in the emission test (see Fig. 4).

The top scale of the meter is calibrated in milliamps of true beam current. This current may be read in microamperes by simply multiplying the scale reading by 1000. In some instances the meter may read somewhat beyond the full scale deflection. This indicates that the gun has extremely high emission current. Current readings greater than full scale will not damage the Model 480.

Proper gray scale tracking in color television receivers can only be accomplished if the three guns of the CRT can supply emission currents which are within a certain ratio to each other. Manufacturer's specifications for this ratio provide that no current can be greater than 150% of any other current. The Model 480 provides an accurate tracking test which greatly simplifies color CRT evaluation.

### Shorts Removal

CRT guns are constructed with extremely small spacing between the cathode and the G1 (control) electrode. This close spacing, together with the possibility of the cathode coating material becoming loose and bridging the gap between the cathode and control grid, often results in a fairly low resistance short between these elements. The presence of such a short will be immediately detected in going through the normal test sequence in the LEAKAGE position.

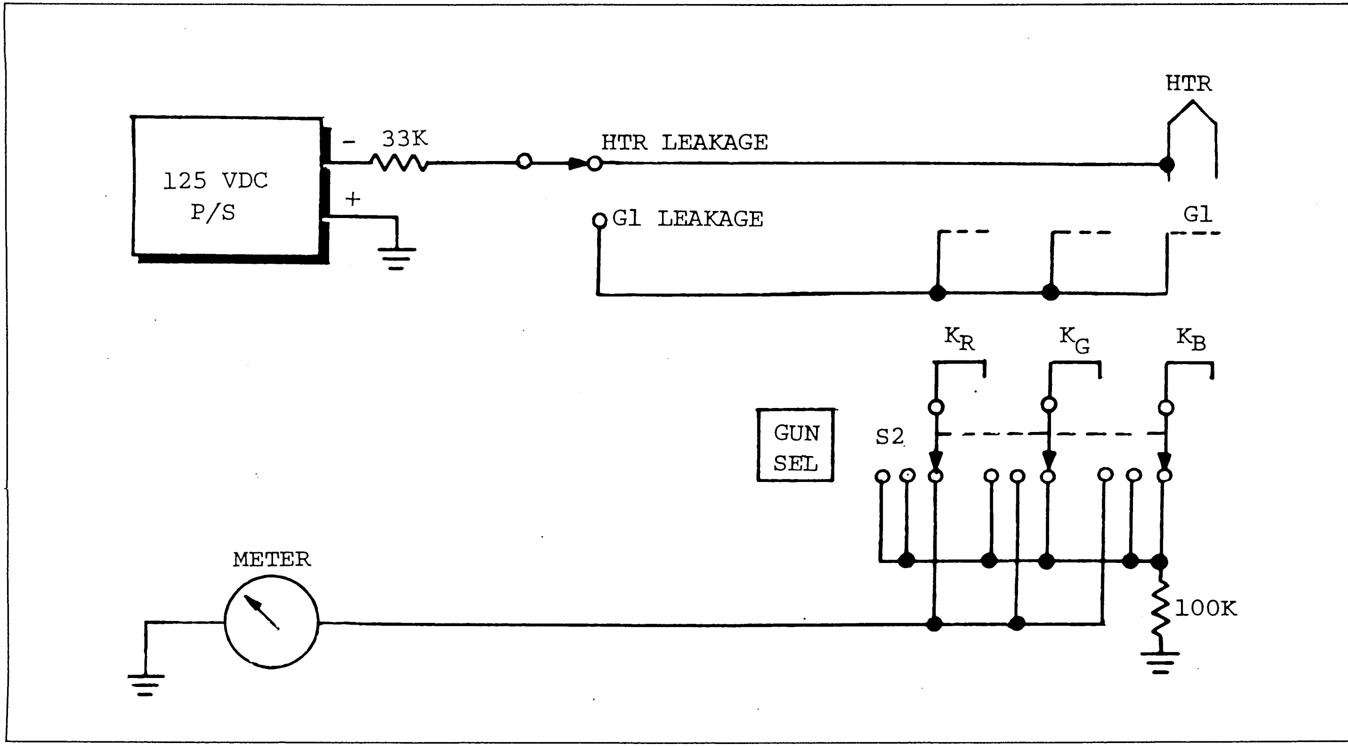



Fig. 3. Model 480 leakage test circuit (simplified).

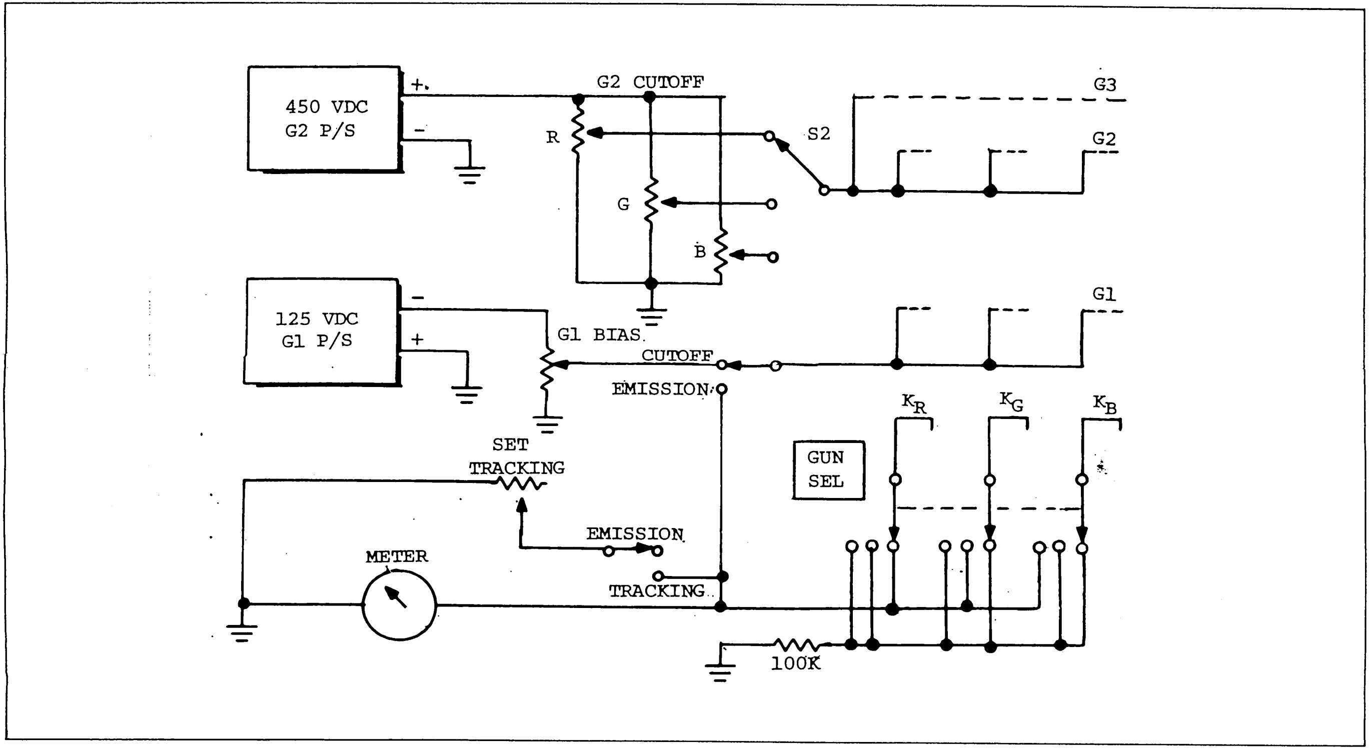



Fig. 4. Model 480 cut-off, emission, and tracking test circuit (simplified).

Such a short usually can be eliminated by means of a high energy discharge from a capacitor. Moving the function switch to the REMOVE SHORTS position and pressing the pushbutton places a capacitor (previously charged to high voltage) across the short. When the short has been successfully burned out, low leakage will be indicated in the leakage test (see Fig. 5).

### Cathode Cleaning and Restoring

The most effective technique for cathode rejuvenation involves elevating the heater voltage and simultaneously applying a high positive voltage between G1 and cathode, thus causing a much greater than normal cathode current to flow. Unfortunately, unless this process is carefully controlled, the cathode can easily be damaged, and instead of improving performance, the emission capability of the cathode is lowered or destroyed.

This problem is avoided in the Model 480 by pre-heating the cathode, and then initiating the rejuvenation cycle by means of a pushbutton which applies the high rejuvenation voltage to the control electrode, while simultaneously removing the heater voltage. This permits a high rejuvenation current to immediately begin flowing as the button is pressed, but only as long as the cathode retains sufficient heat to maintain the temperature required for emission. The rejuvenation cycle is therefore automatically terminated when the cathode cools below the point at which emission can be sustained. This time interval will depend upon both the condition of the cathode emitting surface, and the thermal characteristic of the cathode structure. Larger, more rugged cathodes will result in a longer rejuvenation cycle, and, of course, they are the ones that need and can withstand the longer time interval, with less danger of being damaged. Therefore, the cathode structure itself serves as the automatic timing element that adjusts the interval according to its own needs (see Fig. 6).

## MODEL 490

### Emission Test

The patented multiplex method employed in the Model 490 tests the three guns in a rapid-fire sequence, on a 1/3 duty cycle time-share basis (see Fig. 7). Each gun is pulsed 20 times per second and the peak current of each gun is continuously indicated on its individual meter. The current indicated is "true" beam current - that is, only the current passing through the G1 aperture. A GOOD emission indication on the meter, therefore, assures that (given the high voltage) the gun is capable of producing adequate high-light brightness on the face of the picture tube.

The G2 voltage is supplied by a digitally programmed regulator so that it can be automatically adjusted to the G2 cutoff value of each gun, during the gun's test interval. This is why the set-up and procedure is the same for even those tubes that have a common connection to all three G2 elements.

### Tracking Test

The multiplex system greatly simplifies the tracking test (see Fig. 8). The 1-1/2 to 1 limit for emission between the

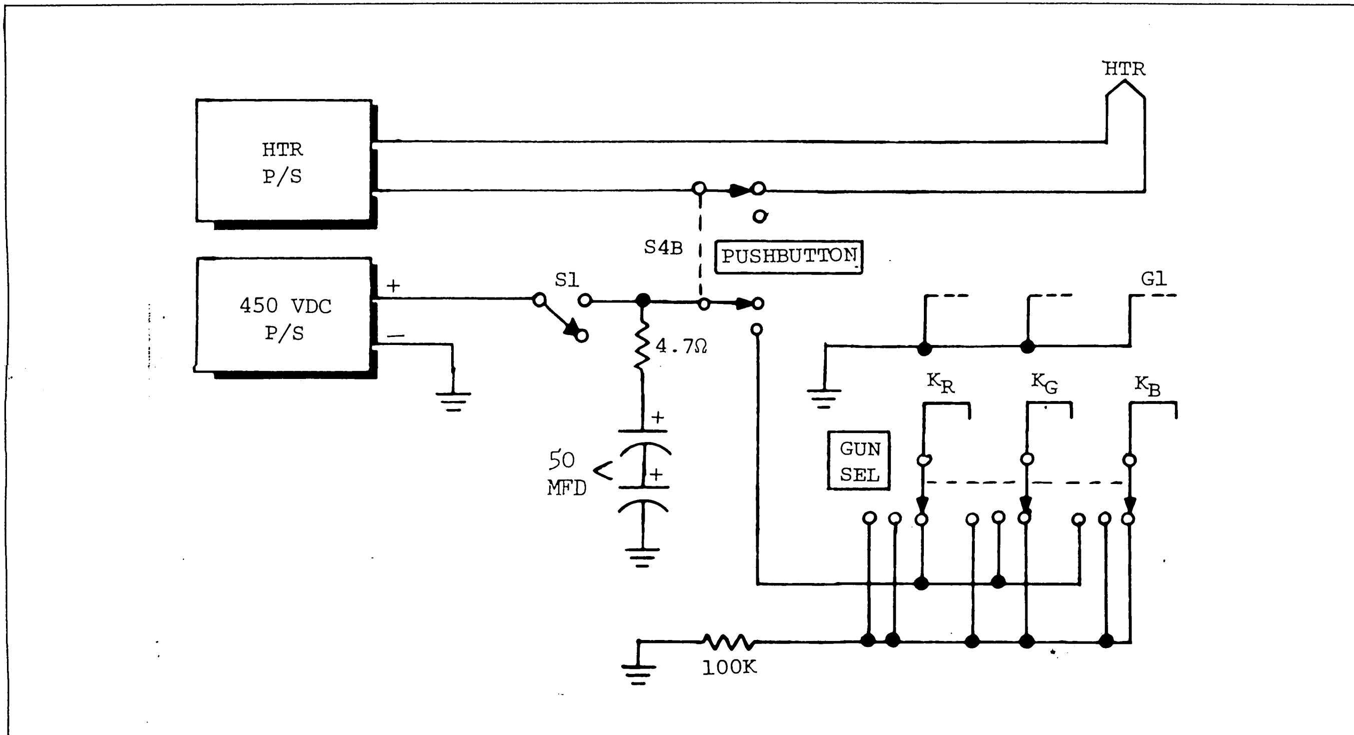



Fig. 5. Model 480 shorts removal circuit (simplified).

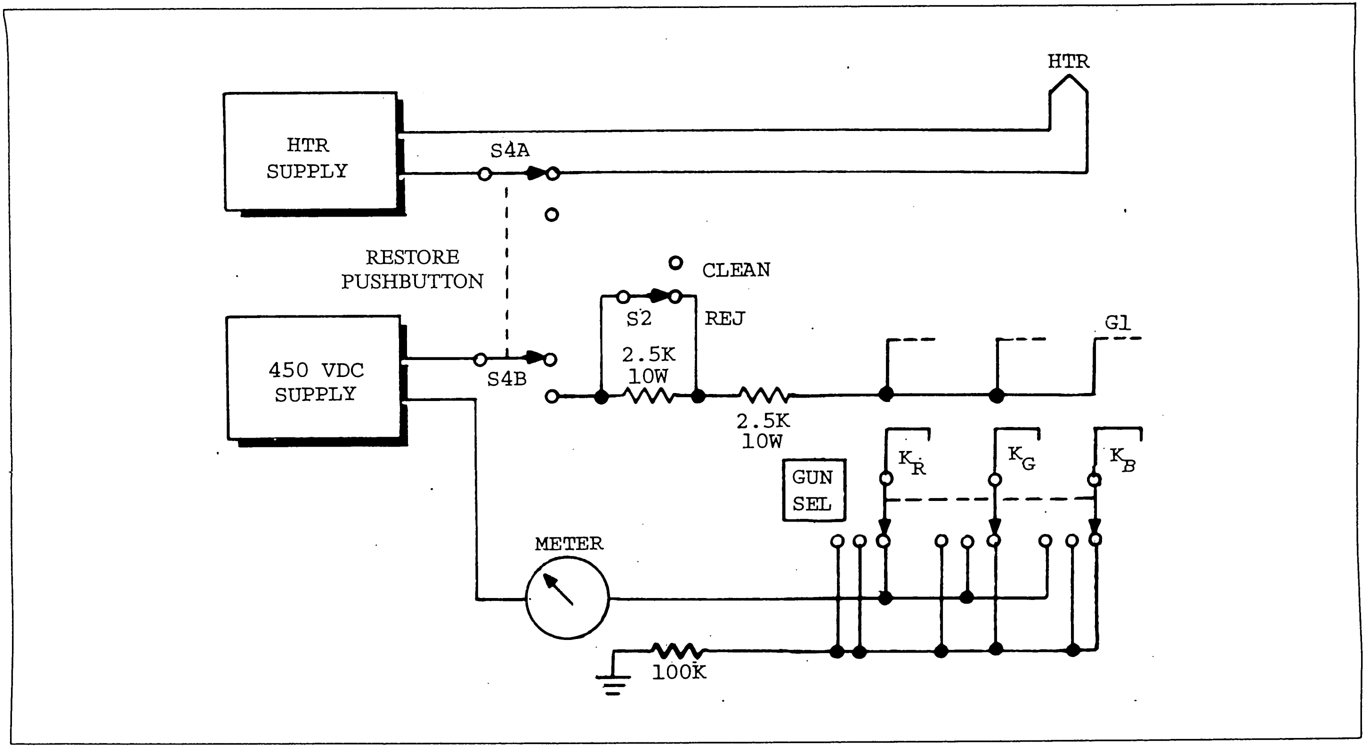



Fig. 6. Model 480 clean, balance, and rejuvenate circuit (simplified).

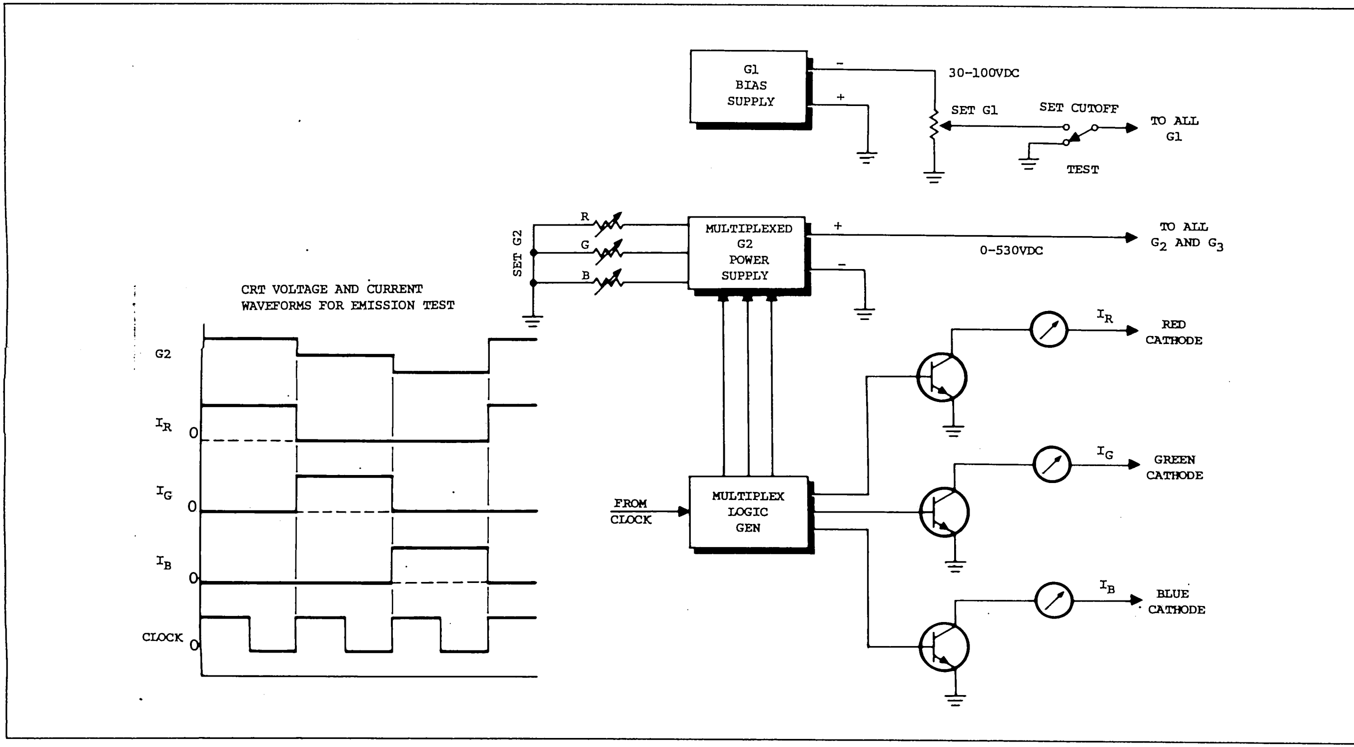



Fig. 7. Model 490 emission test circuit (simplified).

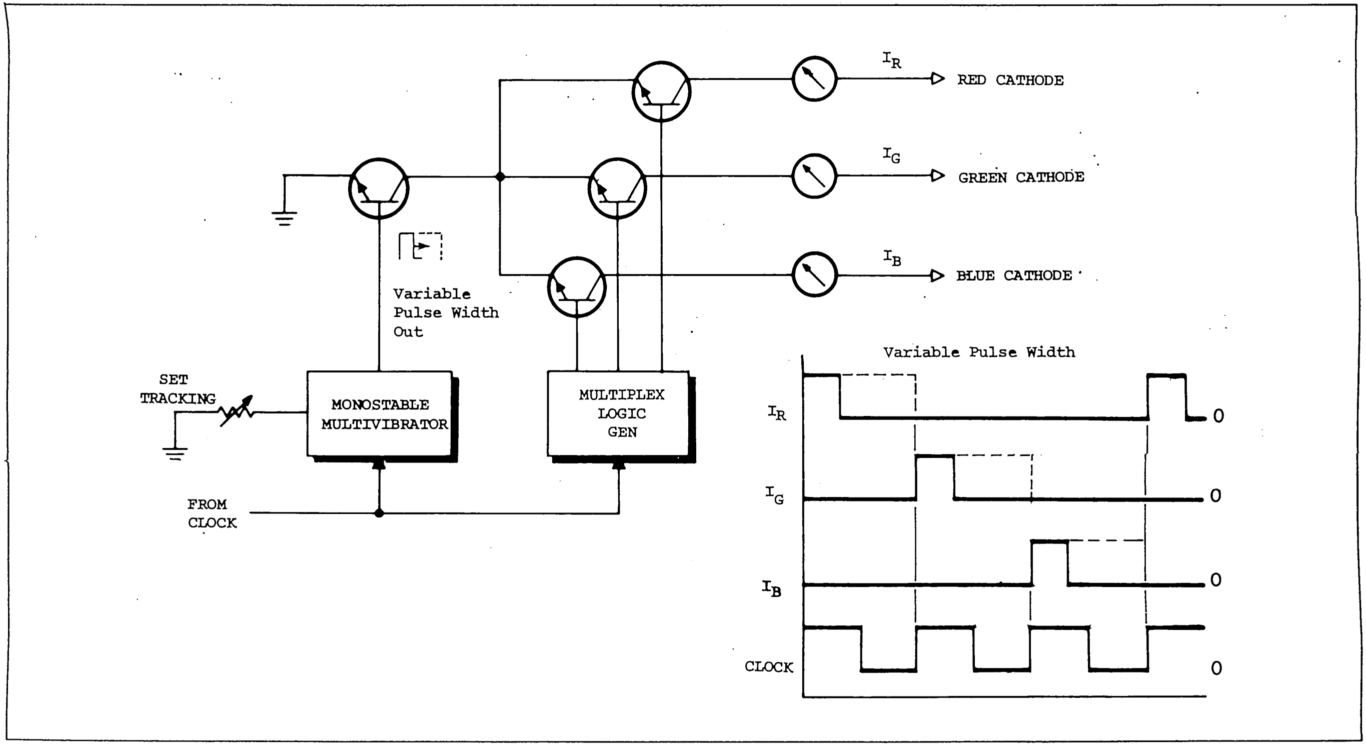



Fig. 8. Model 490 tracking test circuit (simplified).

highest and lowest guns is checked by showing this ratio on the meter scale as a yellow wedge extending upward from the GOOD-BAD limit line. The TRACKING control changes all three meter readings by the same percentage, so that if all three pointers can be placed in the yellow area, tracking of all guns is confirmed. Changing the three meter readings by exactly the same percentage is accomplished electronically by changing the duration of each test interval by exactly the same amount. Thus, if each gun is on for only 1/6 instead of 1/3 of the time, each meter reads 50% of its former value.

**Leakage Test**

The multiplex system simplifies the leakage test (see Fig. 9). Like the limit used to make a GOOD-BAD judgement of emission, a leakage limit somewhat higher than the manufacturer's limit for a new tube is used - a limit at which one might expect trouble to begin showing up in a typical TV set or monitor. Fortunately, such a leakage limit is just high enough to cause a neon lamp to glow. By using a group of five lamps (one for each cathode, one for the heater, and one for G1), and multiplexing the test circuit, leakage can be observed between any two cathodes or from any cathode to the heater or to G1. (Both lamps will glow, showing which two elements are involved.) This test is made automatically with the function switch in the SET-UP position and requires no operator adjustment. It will detect almost any leakage problems that occur, including troublesome cathode-to-cathode leaks.

**Life Test**

If can generally be assumed that CRT's showing high emission levels (1.0 mA and over) will continue to perform acceptably for long periods of time, and that the performance will not be degraded appreciably by abnormal supply voltage conditions such as low heater voltage. However, when the CRT shows emission levels that are relatively low (below 1 mA) even though they may be in the GOOD region, it is highly desirable to evaluate performance both from the standpoint of future life expectancy and behavior at reduced heater voltage. This is particularly true with regard to tracking performance in low line-voltage conditions.

One of the best means of estimating the remaining useful life of a CRT is to observe the decrease in emission with reduced heater voltage. If the performance (either emission or tracking) becomes unsatisfactory with a 15% reduction in heater voltage, then the future useful life of the tube is most likely limited.

To facilitate this analysis in the Model 490, a LIFE test pushbutton is provided which automatically reduces the heater voltage by 15% from any normal value previously set on the heater voltage meter. Simply depressing the LIFE test pushbutton permits very rapid evaluation of both the remaining life expectancy of a CRT and its performance at reduced heater voltage.

Other clues for judging life expectancy are the "warm-up" and "cool-off" behavior of the cathode. These tests are easily performed by applying or removing heater voltage while observing emission. Therefore those sections of the RESTORE pushbutton switches that interrupt the heater supply are arranged to be operative in the TEST position.

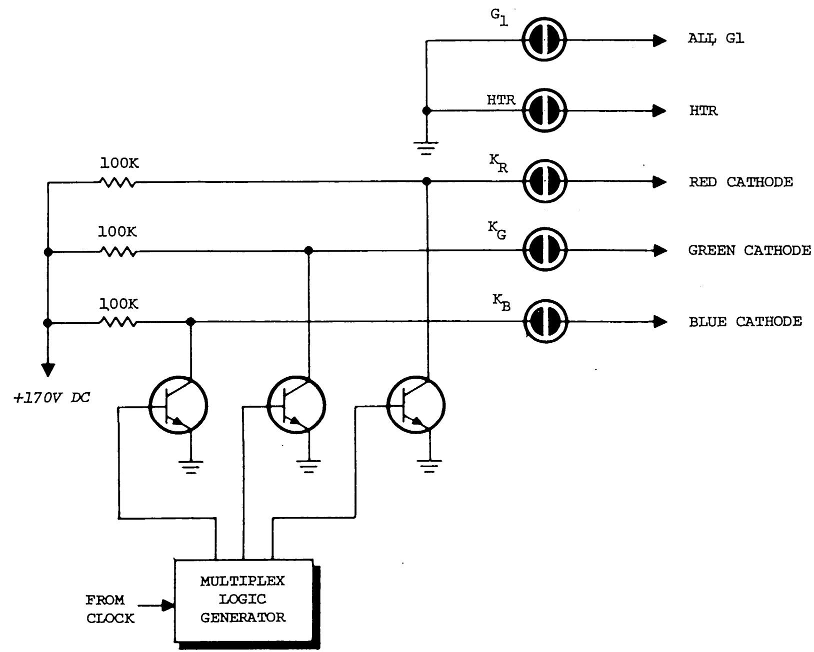



Fig. 9. Model 490 leakage test circuit (simplified).

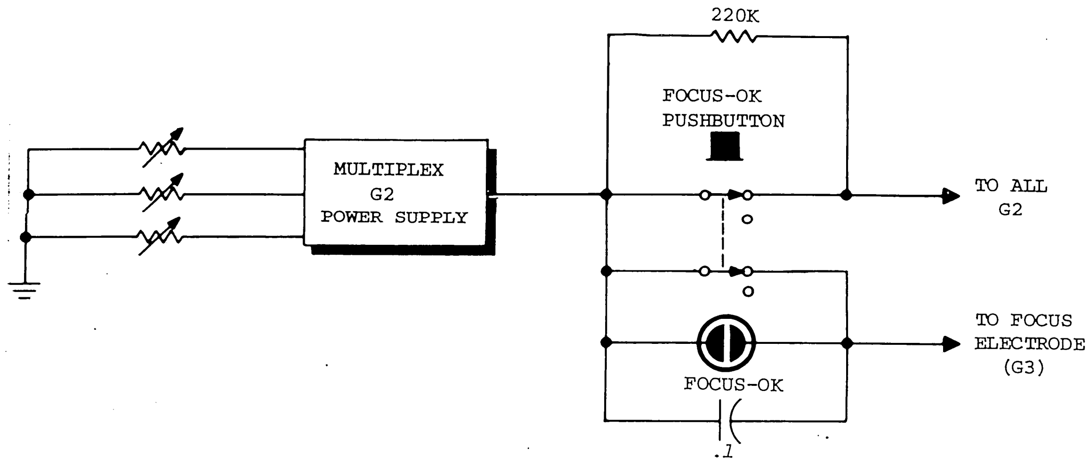



Fig. 10. Model 490 focus continuity test circuit (simplified).

## Focus Test

When the FOCUS OK pushbutton is pressed, a large resistance is connected in series with the G2 electrodes (see Fig. 10). The focus electrode(s), however, is connected directly to the full G2 supply voltage through a sensitive neon lamp. The large resistor reduces the G2 electrode voltage, thus allowing more current to be picked up by the focus electrode, which is indicated by the neon lamp glow.

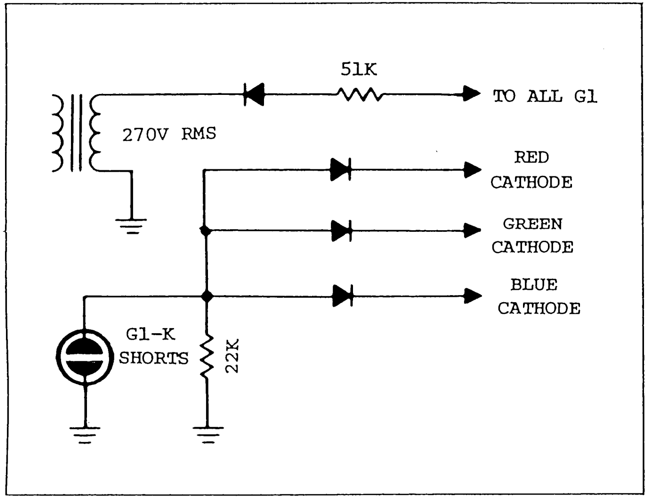



Fig. 11. Model 490 G1-K short indication circuit (simplified).

There will always be some drop in emission when the FOCUS OK button is pressed. Some gun structures will exhibit a large drop and others only a very small drop. Those showing a large drop have a common focus electrode that is virtually a one-piece mechanical structure so that an open connection to a single focus electrode is practically impossible. However, some gun structures exhibiting a small drop may employ separate focus electrodes which are interconnected by a welded metal strap, and an open connection may occur to only one or two focus electrodes. Even if the base pin has continuity to only one focus electrode, the test will still show FOCUS-OK. However, an open focus interconnection to one gun will show a large drop in emission instead of a small drop, thus making it possible to detect the open interconnection.

## Shorts Removal

CRT guns are constructed with extremely small spacing between the cathode and the G1 (control) electrode. This close spacing, together with the possibility of the cathode coating material becoming loose and bridging the gap between the cathode and the control grid, often results in a fairly low resistance short between these elements. The presence of such a short will be immediately detected in going through the normal test sequence with the Model 490, because the LEAKAGE indicator lamps will glow brightly showing which cathode is shorted to G1. Upon moving the function switch to the RESTORE position, another neon lamp (G1-K SHORT) will glow brightly, indicating that a low resistance short exists (see Fig. 11).

Such a short can usually be eliminated by means of a high energy discharge from a capacitor. Pressing the REMOVE

SHORTS button of the Model 490 places a capacitor (previously charged, to a high voltage) across the short (see Fig. 12). When the short has been successfully burned out, the G1-K SHORT indicating lamp will not glow.

### Cathode Cleaning and Restoring

The most effective technique for cathode rejuvenation involves elevating the heater voltage and simultaneously applying a high positive voltage between G1 and cathode, thus causing a much greater than normal cathode current to flow. Unfortunately, unless this process is carefully controlled, the cathode can easily be damaged, and instead of improving performance, the emission capability of the cathode is lowered or destroyed.

This problem is avoided in the Model 490 by pre-heating the cathode, and then initiating the rejuvenation cycle by means of a pushbutton which applies the high rejuvenation voltage to the control electrode, while simultaneously removing the heater voltage (see Fig. 13). This permits a high rejuvenation current to immediately begin flowing as the button is pressed, but only as long as the cathode retains sufficient heat to maintain the temperature required for emission. The rejuvenation cycle is therefore automatically terminated when the cathode cools below the point at which emission can be sustained. This time interval depends upon both the condition of the cathode emitting surface, and the thermal characteristic of the cathode structure. Larger, more rugged cathodes result in a longer rejuvenation cycle, and, of course, they are the ones that need and can withstand the longer time interval, with less danger of being damaged. Therefore, the cathode structure itself serves as the automatic timing element that adjusts the interval according to its own needs. This technique, which prevents simultaneous application of heater and rejuvenate voltage is an exclusive, patented feature of the Model 490's cathode restoring system.

The same procedure can be used at different energy levels by changing the value of the applied voltage. Higher voltage is required for rejuvenation to start the process when the cathode has become an extremely poor emitter. Lower energy should be used to minimize possible damage to the cathode for cleaning high resistance contamination between grid and cathode, and increasing the emission of a good cathode to improve tracking. Therefore, it is desirable to use the lower energy procedure provided in the CLEAN-BALANCE function for those operations.

In describing the emission test earlier, it was pointed out that the Model 490 tests the emission and tracking performance of a CRT by indicating true beam current - that is, only the current passing through the G1 aperture which is useful for producing light output from the face of the picture tube. This beam current is derived from a very small area of the cathode located directly beneath the small aperture hole in the G1 control electrode. Obviously, for the rejuvenation process to be successful, it is from this region that emission must be restored. During the rejuvenation process a very large current flows from the entire cathode surface to the highly positive G1 electrode. Although the amount of current flow from the cathode to G1 is an indicator of the overall condition of the cathode, G1 current itself is of no use in evaluating the ability of a cathode to supply true beam current. Therefore, in order to know the quality of the tube after the restoring process has been completed, it is absolutely necessary to make a true beam current emission test.

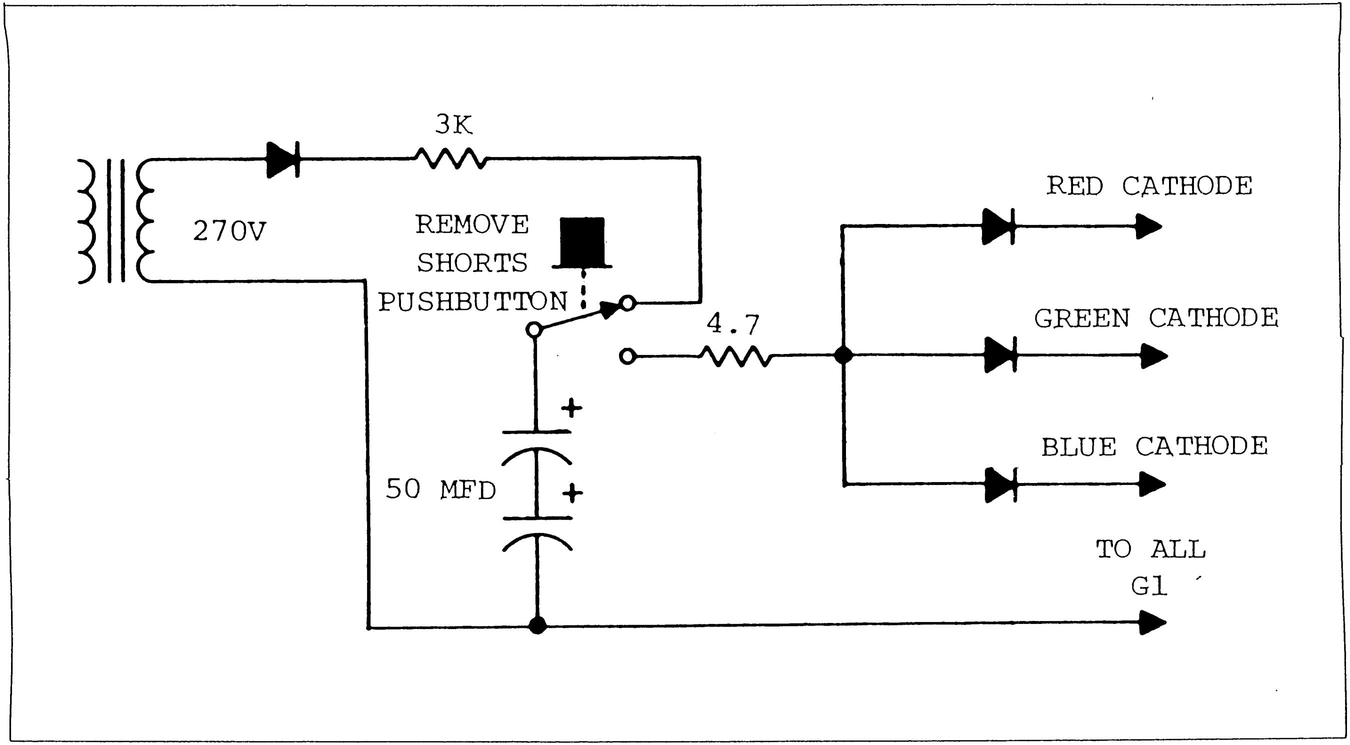



Fig. 12. Model 490 G1-K short removal circuit (simplified).

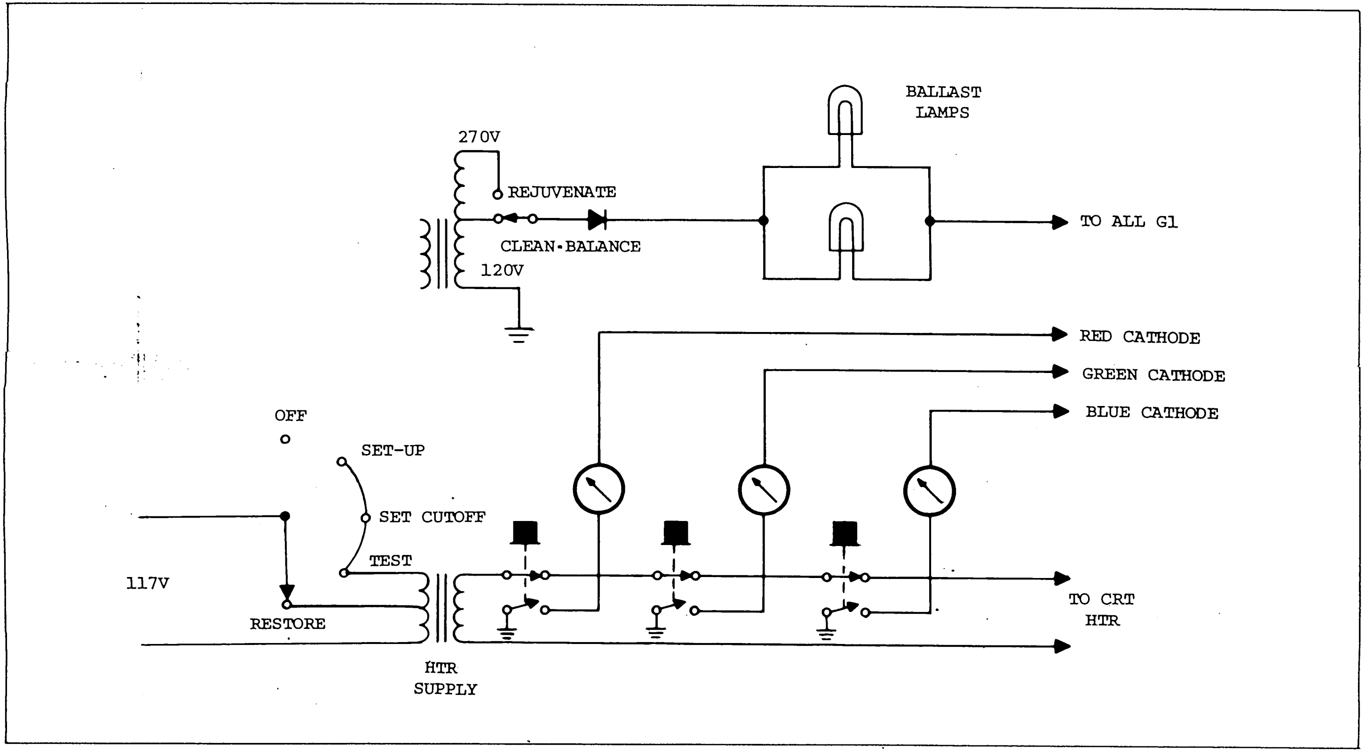



Fig. 13. Model 490 clean, balance and rejuvenate circuit (simplified).

**WARNING**

*The following instructions are for use by qualified personnel only. To avoid electric shock, do not perform servicing other than contained in the operating instructions unless you are qualified to do so.*

*High voltage, up to 600 V, is present when these units are operating. Line voltage (120 or 240 VAC) is present on some components any time the 480/490 is connected to an ac power source, even if turned off. Always observe caution when the chassis is removed from the housing. Contacting exposed high voltage could result in fatal electric shock.*

## CASE REMOVAL

Both Models

1. Remove the lid and disconnect the unit from ac line voltage.
2. Remove the eight screws from around the edge of the front panel.
3. Lift out the assembly (chassis and black inner case).
4. Turn the assembly over and remove the four screws from the bottom.
5. Remove the inner case to expose the chassis.

## FUSE REPLACEMENT

**WARNING**

*Make sure that the unit is disconnected from ac power before replacing the fuse, and be certain that the replacement fuse is the proper value.*

Model 480

1. Expose the chassis as instructed in the "Case Removal" section.
2. Fuse F1 is located on the side wall, near the power transformer. Its value is: 0.3 A, 250 V, 3AG, slow-blow.

Model 490

1. Expose the chassis as instructed in the "Case Removal" section.

2. The fuses are located on the printed circuit board, directly below the RED/B&W meter. Fuse F1 is used in the high voltage circuits, and F2 is used in the heater circuit. Their values are as follows:

   F1: 0.3 A, 250 V, 3AG, slow-blow;
   F2: 3/8 A, 250 V, 3AG, slow-blow.

## FIELD CALIBRATION

Both Models

1. Connect a suitable AC voltmeter (±3% accuracy or better at 50/60 Hz) to pins 1 and 14 of Adapter No. 3. Connect Adapter to test cord.

2. Set AC voltmeter range switch to 10 V.

3. Plug in the Model 480/490.

4. On the Model 480, set the function switch to SET HEATER. On the Model 490, set it to SET-UP.

5. Set HTR RANGE switch 4-7 position.

6. Adjust SET HEATER control on Model 480, or SET HTR control on Model 490, for a reading of exactly 6.3 V on external voltmeter.

7. Perform the following adjustment (located on printed circuit board):
   a. Model 480: adjust R7 so the meter indicates exactly 6.3 V on the HTR scale.
   b. Model 490: adjust R16 so that the RED/B&W meter reads exactly 6.3 V on the HTR scale.

## WARRANTY SERVICE INSTRUCTIONS

1. Refer to the MAINTENANCE section of your **B & K-Precision** instruction manual for adjustments that may be applicable.

2. If the above-mentioned does not correct the problem you are experiencing with your unit, pack it securely (preferably in the original carton or double-packed). Enclose a letter describing the problem and include your name and address. Deliver to, or ship PREPAID (UPS preferred in U.S.A.) to the nearest **B & K-Precision** authorized service agency (see list enclosed with unit).

If your list of authorized **B & K-Precision** service agencies has been misplaced, contact your distributor for the name of your nearest service agency, or write to:

**B & K-Precision**, Maxtec International Corporation
Factory Service Operations
6470 West Cortland Street
Chicago, Illinois 60635
Tel (312) 889-1448
Telex: 25-3475

Also use this address for technical inquiries
and replacement parts orders.

## LIMITED ONE-YEAR WARRANTY

MAXTEC INTERNATIONAL CORPORATION warrants to the original purchaser that its **B & K-Precision** product, and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from the date of purchase.

MAXTEC will, without charge, repair or replace, at its option, defective product or component parts upon delivery to an authorized **B & K-Precision** service contractor or the factory service department, accompanied by proof of the purchase date in the form of a sales receipt.

To obtain warranty coverage in the U.S.A., this product must be registered by completing and mailing the enclosed warranty registration card to MAXTEC **B & K-Precision**, 6470 West Cortland Street, Chicago, Illinois 60635 within fifteen (15) days from the date of purchase.

**Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. It is void if the serial number is altered, defaced or removed.**

MAXTEC shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have other rights which vary from state to state.

For your convenience we suggest you contact your **B & K-Precision** distributor, who may be authorized to make repairs or can refer you to the nearest service contractor. If warranty service cannot be obtained locally, please send the unit to **B & K-Precision** Service Department, 6470 West Cortland Street, Chicago, Illinois 60635, properly packaged to avoid damage in shipment.

**B & K-Precision** Test Instruments warrants products sold only in the U.S.A. and its overseas territories. In other countries, each distributor warrants the B & K-**Precision** products which it sells.

# NOTES

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(continued from inside front cover)

4. Discharge high voltage capacitors after power is removed from the equipment with the CRT. The anode of many CRT's retains a high voltage charge for long periods after power is removed.

5. This instrument applies all the voltages required for testing and restoring CRT's. Therefore, high voltages are present at the adapter socket whenever some test buttons are pressed. The 480/490 should be turned off while the adapter is being connected to the CRT.

6. The proper power line supply voltage is indicated on the chassis where the power cord enters the instrument. Do not attempt to operate this instrument from a power source other than specified.

7. Never work alone. Someone should be nearby to render aid if necessary. Training in CPR (cardio-pulmonary resuscitation) first aid is highly recommended.

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Chicago, Illinois 60635



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